SmartReFlex
RENEWABLE DISTRICT HEATING & COOLING

Initiating 100% RES DHC and Supporting Implementation

Work Package 4: European Activity Report

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smartreflex.eu

Smart and flexible 100% renewable district heating and cooling systems for European cities

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1 About SmartReFlex

The overall objective of the SmartReFlex project is to increase the deployment of smart and flexible district heating and cooling systems with a high share of renewable energy in European towns and cities.

Renewable District heating and cooling (RES DHC) networks are seen as key element of the EU Strategy for Heating and Cooling as they enable the large-scale penetration of renewable thermal energy in urban environment. District heating and cooling networks, together with large-scale heat storage, have also a key role to play in integrating the overall energy system, notably through the conversion and storage of intermittent renewable electricity and the harnessing of waste heat from industry and power stations.

The project was undertaken by a European consortium including partners from Denmark, Germany, Ireland, Spain and Italy, with the following backgrounds:

- Local and regional authorities, as key stakeholders in terms of policy framework as well as practical district heating project development;
- District heating/cooling utilities, providing technical expertise and knowledge about the needs of the sector;
- Consultancy companies with specific skills in district heating and cooling planning and design.

The project focussed on six target regions for implementation of its objectives, namely Catalonia (ES), county Tipperary and Kerry (IRL), Emilia-Romagna (IT), Schleswig-Holstein and Batten-Wurttemberg (DE). Our partners from Denmark provided technical support and know-how transfer from the very successful Danish experience in the area of energy planning and the integration of renewable energy in district heating and cooling systems.

2 About this European report

This report summarises the work undertaken by the partners in the target regions to foster the deployment of district heating and cooling from renewable sources (RES DHC), in the framework of work package 4 of SmartReFlex. You will find hereafter a number of selected case studies on initiatives to improve the policy framework for RES DHC in the participating regions and to support the practical deployment of RES DHC in their towns and cities. We also bring together the lessons learned from these initiatives with a view to guide replication in other regions at early stages of their RES DHC market development. These activities build on a participative process of engaging with key stakeholders, capacity building through training and know-how transfer from our expert partners from Denmark.

Further information on the project activities and the case studies discussed herewith are available on the SmartReFlex website at www.smartreflex.eu

3 Fostering a positive policy framework for RES DHC in participating regions

The participating regions have generally a low penetration of RES DHC. As emerging markets, they have substantial gaps in their local and national policy framework for RES DHC. During Work Package (WP) 2 of SmartReFlex, the partners have engaged with key stakeholders within their region to identify relevant barriers and they have defined regional strategies to overcome them. During WP4, they set out to drive key policy initiatives in areas such as spatial heat planning, consumer protection, subsidies, capacity building, etc. We present herewith a selection of these initiatives with a strong potential for replication in other European regions.

3.1 Update of the Regional Energy Planning in Emilia Romagna

In November 2015 Emilia Romagna Region started the renewal process of its regional energy planning that led to the approval of 2 documents: the Regional Energy Plan 2030 (framework, long term) and the Regional Energy Action Plan 2017-2019.

ANCI Emilia Romagna, as partner of SmartReFlex, was committed to make the regional energy planning favourable to RES DH development. In order to achieve this goal ANCI elaborated a regional strategy available here.

ANCI ER started a consultation involving Regional municipalities to feed into the Regional Plan and teamed up with ARPAE (regional agency for environment and energy) in the framework of two concommittent Intelligent Energy Europe projects (SmartReFlex and RES H/C Spread):

1. the development of a regional heatmap

2. the creation of a catalogue of 52 measures useful for the diffusion RES for Heating and Cooling.

The Regional Energy Plan and Regional Energy Action Plan was first published in August 2016. The Plan included the improvement of District Heating (with renewable energy) in the strategy to meet the regional energy target 2030. This achievement was not granted due to the unfavourable framework conditions described previously.

After the publication, a public consultation was opened. ANCI Emilia Romagna sent its contribution, proposing the implementation of a study on the regional DH potential with a focus on areas off the natural gas network where DH could be an effective option.

In the last and final version of the Plan, the role of efficient and renewable District Heating is improved. The Plan foresees the institution of a regional energy observatory managed by ARPAE. This Observatory will implement a study on DH potential at a regional level.

The co-operation of ANCI ER and ARPAE in the framework of their respective EU projects was very beneficial in creating momentum for policy-framework development, and the regional energy strategy foresees the establishment of a joint task force.

3.2 Kerry and Tipperary, pioneering heat planning in Ireland.

The objective of this case study was to support the integration of heat and district heating into the local energy planning framework in the participating regions, county Kerry and county Tipperary. Kerry County Council, in collaboration with its SmartReFlex partner XD Sustainable Energy Consulting, is developing a Local Heat Plan for the town of Tralee as well as a County Heat Plan for Kerry. The first step was to create a heat density map of Tralee (100 x 100 m grid) and the whole county (250 x 250 m grid), based on a GIS dataset which includes the annual heating requirement of all dwellings and non-residential buildings.

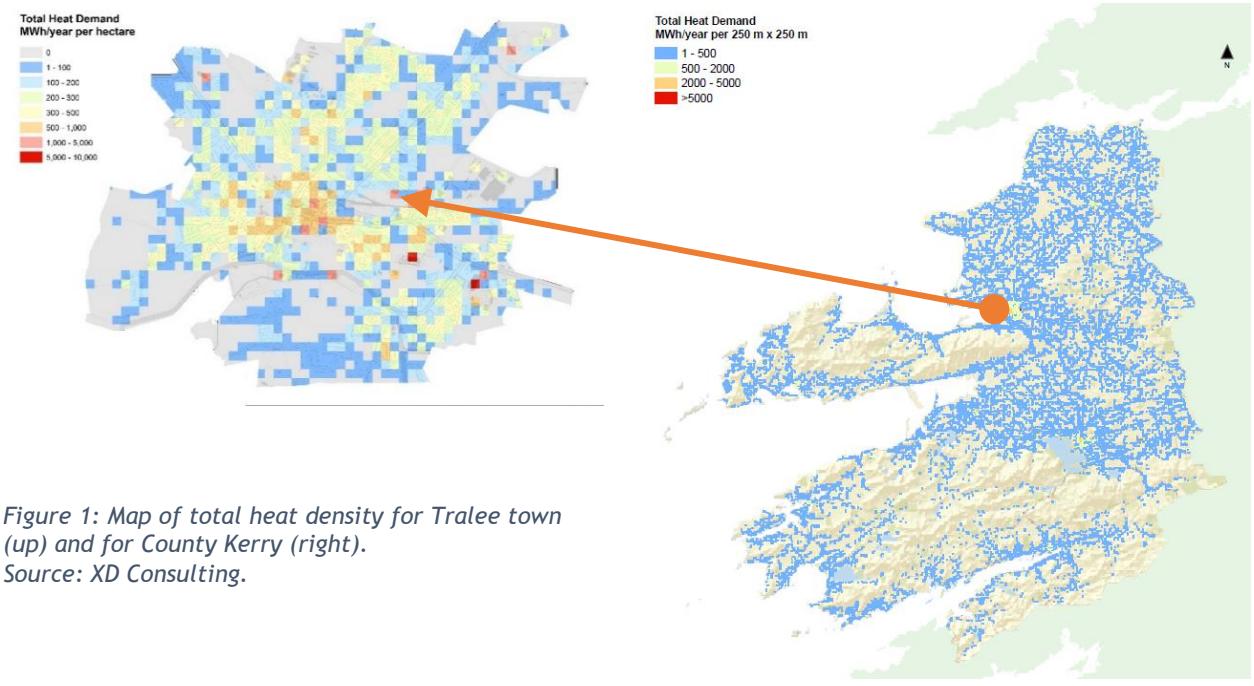
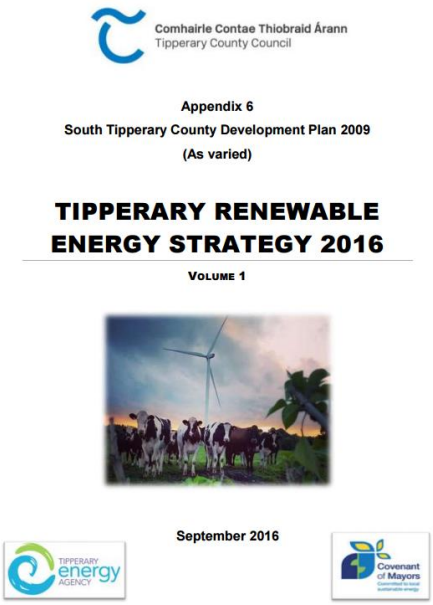


Figure 1: Map of total heat density for Tralee town (up) and for County Kerry (right).
Source: XD Consulting.

Considering the heat density benchmark of 300 MWh/year per hectare set by the EU Heat Roadmap study in terms of district heating feasibility, the heat density data obtained for Tralee indicates that district heating could potentially service close to 60% of the town's total heat demand or 116 GWh/yr. If the same benchmark is applied to the whole county heat density map, it appears that district heating would be feasible in 8 towns in Kerry, for a total heat demand of 124 GWh/yr.

The same heat density dataset was used to derive the total cost of heat distribution per unit of heat sold, for each land area unit on the basis of the methodology applied by B. Moller & S. Werner as part of the EU Heat Roadmap study (2016). The levelized cost of heat production with different 100% RES-heat options was calculated using simple feasibility study tools provided by our PlanEnergi partners as well as the EU Sunstore4 project. These were added to calculate the total cost of heat delivered for each land plot within the town and county. We can now benchmark district heating against individual heating options and determine where RES district heating is competitive. Our analysis shows that district heating could possibly attract a 90% share of the heat market in Tralee, moving from individual heating (allowing for a 20% discount) if cheap renewable heat is available as a by-product of biomass CHP, or a 40% share if it is produced directly by a biomass boiler.

These studies will inform the local authority's spatial planning and development plans for Tralee and Kerry respectively. Additional support is given by the Sustainable Energy Authority of Ireland to leverage the associated know-how to provide a template for other local authorities to develop their heat plans and renewable energy strategies.



In parallel, the Tipperary Energy Agency has assisted Tipperary County Council in the development of its future renewable energy strategy for the county. The Tipperary Renewable Energy Strategy was published in September 2016 as a variation of the County Development Plan 2009. Tipperary's Renewable Energy Strategy calls for the establishment of district heating networks in dense urban areas (Policy RE7) as key to utilising waste agricultural residues for higher value products that support the local economy and reduce the money leaving the economy on expensive foreign oil. In addition, Tipperary County Council has developed a new statutory development plan that contains a full chapter on sustainable energy and provides a high level planning framework for the transition to renewable heat for the county.

Both XD Sustainable Energy Consulting and the Tipperary Energy Agency had the opportunity to promote RES DHC to a wide range of stakeholders in Ireland's local planning system. Approximately 120 planning specialists participated to the Sustainable Energy Authority of Ireland's Local Authority Renewable Energy Strategy (LARES) training course delivered by the Irish SmartReFlex partners. Overall, the local heat planning work undertaken by the SRF partners in Kerry and in Tipperary provides a foundation block for the development of a supportive spatial planning framework for RES DHC at a local level in Ireland.

3.3 Catalonia's Smartreflex Taskforce Spearheading Removal Of RES DHC Development Barriers

The SmartReFlex partners from Catalonia, Incasol and IREC, have been very successful at establishing a comprehensive and productive task force on RES-DHC. This task force is an 18-member working network where the main stakeholders RES-DHC development in the region are represented. The task force has met on a regular basis to address key development barriers and opportuities, such as organisational, financing, fiscal, technical, environmental and planning issues.

Regarding planning, we have collected and studied different examples where urban regulations have been used to promote RES DHC and, notably the legal framework required to guarantee users' connection to the network. This regulatory framework proposals also include provisions for space allocation for generation plants, reservations for network installation as well as for the location of heat interface units in apartments.

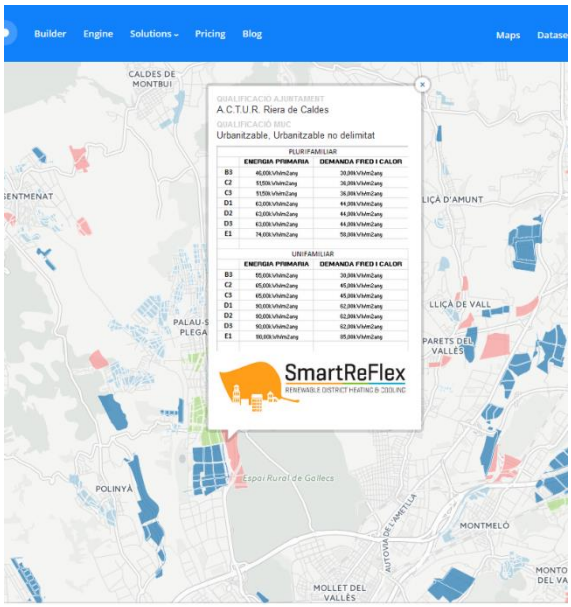


Figure 2: Example of interrogation of Catalonia Heat Map viewer. Source:INCASOL.

In addition, the partners have worked towards the development of a Heat Map tool for Catalonia, which provides geospatial information of heat demand as well as renewable energy resources, on a plot by plot basis. The Heat Map consists of online viewers harnessing pre-existing datasets previously dispersed between different public bodies, as well as information on past DHC projects analysis. Our viewers are intended to make the development of new projects easier, by giving an estimate of both the expected new demands in urban centres and in industrial areas, and also potential renewable energy sources. This information will assist developers in forecasting the viability of RES DHC projects at early planning stages. The viewer can be accessed here.

Overall, the Catalan task force has been very proactive in studying and find solutions to problems affecting existing and potential RES DHC throughout the region. Given the success of the task force, its members intend to continue collaborating and learning from each other in the framework of annual meetings.

3.4 Improving the policy framework for district heating in Schleswig-Holstein

SmartReFlex's regional partners for Schleswig-Holstein have conducted a number of actions to improve the policy framework for RES DHC. First of all, they contributed to establishing a screening process for the integation of renewables in district heating networks in the region which considers available heat sources and heat demand, opportunities to expand the networks, land availability for solar thermal and other renewable energy sources, as well as relevant activities of the municipalities concerned. This information is intended to identify areas of strong RES DHC development potential and assist initial project planning stages.

The second area of intervention concerned improving the legal framework for RES DHC by amending the State's Energy Transition and Climate Law to require increased transparency and consumer protection in relation to heat pricing and renewable energy integration.

In addition, the state of Schleswig-Holstein offers a free initial consultation for local communities in the framework of the Energy and Climate Protection Initiative (ECI) of the Federal State, which is affiliated to the Energy Agency Schleswig-Holstein and works on behalf of MELUR. The aim is to strengthen and inform municipalities, provide expert advice as well as technical and financial support in RES DHC project identification and development. In regular, well-attended events, best-practice examples from Schleswig-Holstein are presented by the project stakeholders as part of study tours.

3.5 Addressing land availability for solar district heating in Baden-Württemberg

A major obstacle to the implementation of RES DHC systems is to find and develop suitable land in or near urban areas, in particular when it comes to large-scale solar thermal installations. To address this barrier, the Ministry of the Environment of Baden-Württemberg organised a stakeholder workshop in Stuttgart on 11.04.2016, which gathered representatives of the Ministry of the Environment, the Ministry of Rural Affairs and Consumer Protection, solar thermal companies, nature conservation associations, utilities, ... The following topics were the subject of focussed roundtable discussions:

- Qualitative and quantitative assessment of suitable lands.
- Legal framework governing land use, including permitting.
- Conflict between climate protection, agriculture and nature conservation.
- Ecological quality of the open spaces (eg use as compensatory measure).

Overall, there was agreement among stakeholders that finding and acquiring suitable land for the heat generation plants was a critical aspect of RES DHC project development. Discussions on how to address this barrier highlighted the following potential solutions:

- Planning privilege of solar thermal plants.
- Tax incentives for farmers to sell land.
- Ecological rating system to encourage high-quality eco-concept.
- Support when engaging with local authorities for project development.

Furthermore, the following steps have proved to be useful when developing RES DHC projects:

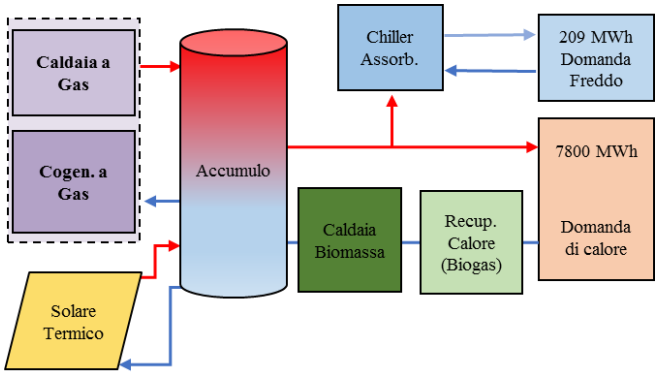
- Systematic land screening against robust suitability criteria.
- Early involvement of authorities, citizens and stakeholders.
- Development of an ecological utilization concept.

4 Supporting RES DHC Project Development in Participating Regions

4.1 Expanding Mirandola's DHC with renewable heat to support urban regeneration while improving air quality.

Mirandola is a town of approx 24 000 inhabitants in the province of Modena with 2193 DD (degree days). There is an existing district heating network in the municipal area, managed by the utility Aimag S.p.A., which extends for 4.4 km serving approximately 20 users and a small district cooling network. The main goal is to reduce the system's dependence on natural gas, and its price's unpredictability, by exploiting a local biomass resource and solar heat. Solar heat is of particular interest to reduce air pollutant emissions associated with biomass combustion (PM10 and BaP, SOx and NOx). The Emilia Romagna region lies in the Po valley, the largest plain area in Italy, and is experiencing several problems in maintaining air quality standards due to human emissions and the valley's topography.

Regional SmartReFlex partners supported the local heat utility by conducting a cost-benefit analysis of alternative systems, including their environmental impact, using the technico-economic simulation software EnergyPRO. Solutions proposed, with different sizes of solar collector areas, have an investment cost range of € 0.7-1.8 million, payback time of 5-8 years and RES fraction of 35-70%. The final choice has been the addition of a biomass boiler, a solar thermal plant of 2500m2 and a storage tank. The extension of DH and the purchase of solar collectors and biomass boilers has been put on the 2018 business plan of the utility.



Sol.	*Biomass boiler*	*Solar thermal*	*Storage*
1	1 MW	-	200 m^3
2	1 MW	1600m^2	160 m^3
3	1 MW	2500m^2	1000 m^3
4	-	1600m^2	160 m^3

The case study results were useful for the utility in the relationship with the local authority, notably to facilitate the process of authorization of the new plants and, in particular, for its large solar thermal array. This case is a good example of integrated energy and urban planning. The extension of the DH line will feed neighbourhoods that have been heavily affected by a ruinous earthquake in 2012, as an integral part of their renovation process.

The first concrete result towards the implementation of the extension project was the official approval by the Municipality of Mirandola (dated 12.16.2016) of "the agreement between the City of Mirandola and AIMAG utility for the construction of underground services and district heating network in the historical center

More details on this and other Italian case studies undertaken as part of SmartReFlex can be found here.

4.2 Integrating Large-Scale Solar Thermal Energy in Trappenkamp's District Heating, Schleswig-Holstein

The municipality of Trappenkamp is located in the southern part of Schleswig-Holstein, 80 km north from the city of Hamburg. The municipal utilities of Trappenkamp provide district heating, natural gas and water for the municipality for 5.000 inhabitants – and have always been open-minded about innovative projects. Not less so when MELUR and the Hamburg Institute suggested a co-operation on the idea of integrating renewables in their district heating, in the form of a large-scale solar thermal plant.

SmartReFlex partner Hamburg Institut has supported the municipality of Trappenkamp by carrying out an economic analysis of their current district heating system, by developing proposals for future solutions and studying their feasibility.

Figure 3: Examplary 8300 m2 evacuated tube collector system in Senftenberg, Germany. Source: Ritter Solar.

These are the key findings of their analysis:

- With the end of the CHP premium payment in approximately two years, the profit for the municipal district heating utility will deteriorate significantly. The operation of the CHP-plants will become uneconomical for long periods from then on due to lower revenues from the sale of power on the electricity market.
- The proposed 2.5 million investment in a large scale solar thermal plant (5000 m2 collector array) to cover the summer load would increase the gross profit in the district heating within current the CHP operating conditions.
- There are attractive regional and federal funding schemes in place that could cover parts of the investment in the solar thermal plant, and increase the return on investment further.
- The solar heat is already competitive with fossil fuels today and could stabilize the heat production cost of the district heating system for the next 25 years. The projected cost of solar heat is 3-4 cents/kWh.
- Solutions with a high solar fraction would be feasible and economical with large scale thermal storage.

Following the support provided by the SRF partners as part of this case study, the municipality of Trappenkamp has decided to go ahead with the project and has initiated its implementation. Their key issue now is to provide the land required to install the solar thermal collector field. For further information on this case study, please contact Hamburg Institut (maass@hamburg-institut.com).

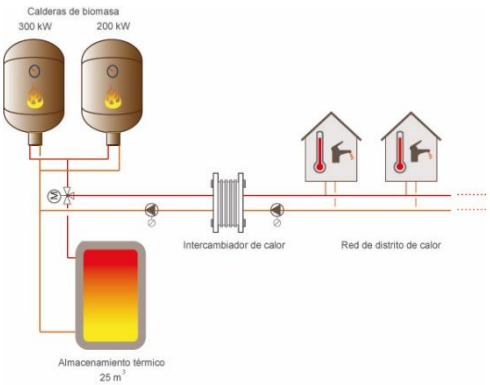
4.3 RES DHC for L'Estrella's eco-efficient neighbourhood in Badalona, Catalonia.

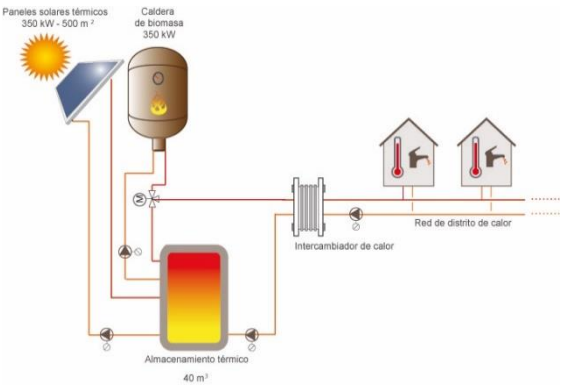
The neighbourhood of L'Estrella, in Badalona, foresees the construction of six new buildings in an existing neighborhood which should have a high energy performance. SmartReFlex Catalan partners, Incasòl and IREC, supported the local authority in the study of a DHC network to provide thermal energy to this group of buildings. The assessment has been done at urban planning level and carrying a technical, economical and environment feasibility study.

The knowledge gained during the project SmartReFlex served as a basis for the redaction of several articles which were included within L'Estrella's urban plan. The objective was to facilitate the implementation of a DHC in the neighbourhood and to promote the use of biomass as a fuel source. Moreover, the project experts worked with the municipality and a local task force established in the framework of SmartReFlex to assess the design, contractual and legal aspects of the project.

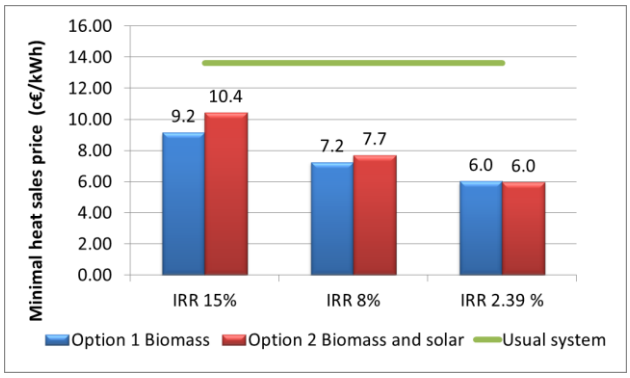
The main challenge of the feasibility study was to apply a DHC network in a high energy performance building development, with low energy demand. The total heating and cooling demand is 1,112 MWh/y for heating and 518 MWh/y for cooling. After a first assessment, it was established that district cooling was not an option due to the low cooling requirements. However, district heating with 100% renewable energy was determined to be a feasible solution.

Two options were studied, first two biomass boilers (300 kW and 200 kW) with 25 m^3 heat storage and second a biomass boiler (350 kW) combined with solar collectors (500 m^2) and 40 m^3 heat storage.





This last option achieved a solar fraction up to 30% in summer. Results show that both options are more economically advantageous than conventional heating systems. The calculated price of the heat delivered in both DH options is cheaper than the individual boiler heating solution, considering different Internal Rate of Return (IRR from 2% to 15%).



Considering the environmental impact, both options reduce by 95% the CO_2 emissions of the individual boiler heating solution.

Therefore, case study of L'Estrella validates the economic feasibility of 100% renewable energy based district heating for a new low energy district in Mediterranean climate.

For further information on this case study, please contact IREC (lsiso@irec.cat).

4.4 RES DHC for all heat users in Tralee town centre.

Tralee is the largest town in county Kerry (16 km2) and is its administrative centre. The town has a population of 23,700 and has a strong service sector in retail, tourism, education and professional services. This SmartReFlex case study aimed to analyse the feasibility of the full deployment of district heating, to service the residential sector and the services sector within the town centre, with alleviating fuel poverty a key objective of the project. The heat demand of the town centre target area (1532 potential heat users, 44,626 MWh/yr, 54% residential) was estimated on the basis of the heat mapping case study discussed above.

An initial district heating system design was undertaken as part of a joint research project between XD Sustainable Energy Consulting and OPTIT (www.optit.net) , using OPTIT's district heating geospatial modelling tool and the GIS heat map dataset for Tralee developed by XD Consulting. The district heating system design has a total network length of 35.6 km and a weighted average pipe diameter of 70 mm. The total capital cost was estimated at 22.7 million euro. The average linear heat density of the network is 1.5 MWh per meter.

Figure 4: Initial design Tralee town centre district heating, based on OPTIT simulations. Source: OPTIT, 2017.

Two RES heat supply options have been analysed as part of this feasibility study, one with a biomass CHP unit (option A, total capex of 14.5 Mio€) and one with a biomass boiler (option B, total capex of 9.3 Mio€). Both options use LPG boilers for peak loads and back up (circa 20% of the total heat produced). The overall energy system (heat production and district heating) lifecycle was modelled with the EnergyPro software to carry out a technico-economic feasibility study of both options, with the assistance of our partners in Grøn Energi.

The following table presents key economic performance indicators on the lifecycle cost analysis of option A & B for a number of reference cases (without considering the cashflow generated by the financing of the project):

- No incentives;
- Renewable feed-in tariff (REFIT) payment for the electricity generated by the CHP (option A), as currently applied in Ireland;
- Renewable heat incentive for RES-heat sold (option A and B), as currently applied in the UK.

The average price of heat sold was taken as €80/MWh which is considered competitive against individual heating options when taking into account fuel, boiler efficiency and maintenance costs.

	Option A - Biomass CHP			**Option B - Biomass Boilers**	
KPIs	No RHI, no REFIT	No RHI, REFIT @ €126/MWh	No REFIT, RHI @ €40/MWh	No RHI	RHI @ €25/MWh
Revenue Y6 (k€/yr)	6,179	7,647	8,424	5,104	6,570
IRR (%)	2.5%	7.9%	10.40%	2.4%	8.4%
NPV (k€)	-12,666	7,944	18,540	-11,363	8,548

Notes: IRR is Internal Rate of Return, NPV is Net Present Value.

Based on the technical and economic assumptions we have , these results show that some form of economic incentives are required to achieve feasibility. The policy initiatives undertaken by the Irish government to prepare for the reform of the REFIT and for the establishment of an Irish RHI are timely in this regard. Irish SmartReFlex partners have proactively engaged in the goverment's consultation process for these policy initiatives, to share the lessons learned from the RES DHC case studies they have completed.

In terms of CO_2 impact, options A and B result in avoided emissions equivalent to putting 10,460 and 6,525 cars off the road, respectively.

To find out more about this case study, please contact XD Sustainable Energy Consulting Ltd (xavier@xdconsulting.eu).

4.5 New cooperative owned RES DHC for the Schopfloch municipality, Baden-Württemberg

This case study concerns a local 100 % RES DH system planned in the municipality of Schopfloch, situated in a rural area of Baden-Württemberg at the border of the Black Forest (2.600 inhabitants, www.schopfloch.de). In 2013, the citizens of Schopfloch started an initiative to found an energy cooperative and to build a local RES DH system (www.beg-schopfloch.de), with a vision for environmentally responsible and resource efficient energy supply.

Following a feasibility study, the concept of a district heating system based on biomass and solar thermal with a high solar fraction was retained. The proposed district heating network would be about 8 km (100 / 60 °C), and it would service up to 190 buildings with a total heat demand estimated at 6,600 MWh per year (heat density of 0.86 MWh/year per m of transmission pipe). The heat production plant would include a wood chip boiler (1.7 MW), a solar thermal plant with 10,000 m² flat plate collectors, a thermal energy storage (10,000 m³ water volume) as well as a wood pellet (0.55 MW) and an oil boiler (2.2 MW) for peak loads. While natural gas had recently been brought to the municipality, the project stakeholder decided to stick with the 100% RES-heat vision.

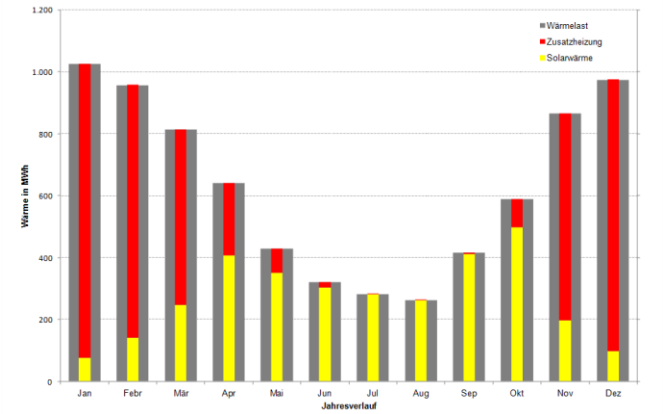


Figure 5: Heat demand (grey), bioenergy supply (red) and solar thermal supply (yellow) yearly supply. Source: Solites.

Detailed calculations of the solar thermal system and its lifecycle costs were undertaken by SmartReFlex partner Solites. With this configuration a 100 % renewable heat supply with a yearly solar fraction of 43 % was calculated with competitive solar generation costs (including subsidies) of 53 Euro/MWh.

The success factors and barriers for the initiation and development of the project in Schopfloch have been:

Success factors

- Dedicated citizens that foster the project development (regular meetings, inviting experts, etc.)
- Active energy group with different competences, e.g. financing issues, involving and motivating the citizens in participating at the project, etc.
- A competent planner that has know-how in planning of small district heating networks and in RES heating installations.
- A planner that is willing to work with a co-operative and the specificity of their management structures and financial constraints.

Barriers

- Difficulties in finding a bank for the financing of the project due to the high investment cost.
- Difficulties in the founding process of the energy cooperative. The process is not yet completed, notably due to the still unclear project financing situation.

For further information on this case study, please contact Solites (info@solites.de).

5 Lessons Learned and Recommendations for Replication

The SmartReFlex partners and the stakeholders involved in the project had generally a strong learning curve during its implementation. Here are some of the most significant lessons the case studies they undertook as part of the work package 4 had to offer.

As one of the major findings was that it is necessary to bring together the ideas and goals of the different actors in the region from the outset, around a common RES DHC development process. The regional task forces were essential to create a group dynamic at a local level and to assemble the skillset and experience required to generate constructive discussions, knowledge exchange and support problem solving. The task forces will be a strong legacy of the project and we are confident that this team work will continue in the future. Recommendations on setting up and animating a task force group in your region are available on SmartReFlex's website.

More generally, it is important to engage with the wider community at an early stage of RES DHC project development. Project advocates should organise regular local meetings with citizens, political representatives, businesses, environmental activists, etc. to keep them informed of the project and consult them about key issues that concern them. Such awareness-raising and information exchange also has the benefit of fostering uptake to the RES DHC system by local heat users.

In most cases, SmartReFlex provided a framework to pioneer heat planning in the participating regions. Heat Maps were created on GIS platforms to provide georeferenced data on heat demand, renewable energy and waste heat resources. The project partners have demonstrated how Heat Maps can be used to support spatial planning for RES DHC projects, screen land for large-scale solar thermal systems and facilitate high level feasibility studies. The methodologies applied for heat planning can be replicated to underlie RES DHC development in other emerging markets.

The feasibility studies undertaken in the framework of work package 4 were essential in applying the partners' technical and financial know-how acquired, and to research appropriate business models for RES DHC projects. The case studies presented in this report, and in the national case study reports, highlighted key issues affecting the viability of RES DHC projects. Achieving sufficient heat density is an important factor for cost effective heat network deployment and different approaches have been tested in the case studies a) focus on large users (e.g. Killarney), b) high density new, low-energy residential development (e.g. L'Estrella), c) all heat users targeting in town centres (e.g. Tralee).

In lower-density rural villages and towns, and in areas where the viability of heat networks is more marginal, financial assistance can be necessary to get projects off the ground.

Alternative, innovative business models to develop and sustain RES DHC should also be part of the solution. Externalities such as reduced air pollution, job creation and local resources valorisation can justify such assistance. In that way, the deployment of small RES DHC in rural communities can be an important engine of socio-economic development.

However, the current low cost of fossil fuels for heating is a strong impediment to the feasibility of RES DHC, especially where natural gas is available. While government intervention in the form of premium payments for RES-heat (such as the RHI) can help overcome this barrier, fossil fuel taxation is recommended as a more sustainable, long-term solution. This has proven a very effective tool in supporting RES DHC in Denmark.

It must be noted that several partners found it difficult to obtain reliable capital and operational expenditure data for district heating networks, in a context where very few district heating projects have been built and information on their costs is not readily available. We recommend that a concerted effort is made by project developers and the RES DHC supply chain, to establish open source cost data relevant to local conditions to facilitate feasibility studies.

In most case studies, biomass stands out as one of the most available and affordable renewable resources. However, air pollution due to biomass combustion needs to be considered carefully and legislated appropriately to avoid adverse health impact and opposition by local population. Equally, several of the case studies undertaken in the southern as well as the northern participating regions demonstrate that large-scale solar thermal systems are technically and financially viable solutions to move towards 100% RES DHC. However, the availability of affordable land for solar thermal collectors' installation is a critical factor in many cases and needs an integrated planning approach which considers competing land use and environmental impacts.

Collaboration with local authorities as key stakeholders for RES DHC development, has been an important aspect of SmartReFlex. The capacity building and technical support provided the SmartReFlex partners has enabled to raise confidence and ability to successfully create a favourable local policy framework and to mobilise projects.

The next steps will include leveraging the data of the feasibility studies undertaken to develop the proposed projects into bankable investments. There is an opportunity for the local authorities involved in seeking Project Development Assistance from the ELENA facility of the European Commission. This would support additional activities such as stakeholder and community mobilisation, financial engineering, business plans, technical specifications and procurement procedures.

6 Conclusions

In conclusion, SmartReFlex has provided a framework to support the development of RES DHC by addressing a number of key barriers in the participating regions:

a) Lack of familiarity among stakeholders;
b) Insufficient support at institutional and policy level;
c) Low capacity in the supply chain for project development;
d) Poor understanding of technical and financial feasibility factors affecting projects.

The task forces established in each region have provided a forum to educate key stakeholders, engage in fruitful discussions about barriers and potential solutions, and generally generate commitment towards RES DHC development. The Regional Strategies prepared under work package 2 build on this engagement to define action plans to remove barriers and foster RES DHC deployment. The training workshops organised as part of work package 3 has built the know-how and skillset required to deliver good quality RES DHC projects among the regional and national supply chains.

The practical activities undertaken in work package 4 have provided SmartReFlex partners the opportunity to contribute to reinforcing the regional policy-framework as well as to support the development of actual RES DHC projects. A integrated approach to problem solving in collaboration with stakeholders has been a key feature of the SmartReFlex project. Overall, it will leave a leave a strong legacy of knowledge and confidence in the participating regions that will sustain future RES DHC development.

This European wide report and its national counterparts will hopefully have helped other regions and countries with emerging RES DHC to learn from our experience and to replicate our success stories. To find out more, we encourage you to visit our website (www.smartreflex.eu) where you will find a range of resources such as:

- A guide for regional authorities on approaches to develop RES DHC;
- Recommendations on how to set up a task force and involve key stakeholders;
- Six regional strategies for RES DHC deployment;
- Training material in English, Spanish, German and Italian on design and planning, technical, financial and organisational aspects of RES DHC development;
- National case study reports providing further details on all the case studies undertaken by the project partners.

For further information, please do hesitate to contact individual project partners (see contact details on the project website) and/or the project co-ordinator:
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